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Art. XXII.—*The Kerrie Series and Associated Rocks.*

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(With Plate XXIII.)

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1. Introduction.

The present paper is the outcome of field work in the area to the north and north-west of Riddell, and includes parts of the parishes of Kerrie, Monegeetta, and Rochford. Detailed mapping was confined to the areas where the conglomerates outcrop. Heights are aneroid heights, using the railways levels as a base. Traverses were made by compass and chain, using the theodolite surveys of the Lands Department as a check.

During the course of the work it became necessary to visit some of the surrounding areas. The area around Gisborne was visited under the guidance of Mr. W. Crawford, of Gisborne. While the actual mapping was confined to a small area, the geology of the surrounding districts has been considered in so far as was necessary for the problem in hand.

The conglomerates which have been studied, although recognised by the Geological Survey, were not named until 1892, when T. S. Hart used the term "Kerrie conglomerates." Since the present work shows the continuity of these conglomerates and that thick beds of sandstones are associated with them, the term "Kerrie series" has been adopted to designate this group of rocks.

2. Physiography.

In broad outline the physiography of the area is fairly simple. Basaltic plains extend along the south and east of a mountainous area of granitic and dacitic rocks, which are flanked by Lower Palaeozoic rocks. The contrast between mountains and plains is intensified by the open clear character of the latter compared with the timbered and scrubby nature of the former.

The basalt plains junction near Clarkefield at a level of just over 1,000 feet. One plain, gradually rising to a height of over 1,600 feet, extends northwards towards Lancefield. The monotony of the plain is broken by a few points of eruption which rise to nearly 2,000 feet. The Macedon Ranges form the western edge, and the Lower Palaeozoic hills near the Deep Creek mark the eastern edge of this plain. The other stretch of flat land rises gradually to the west to just over 1,500 feet to the north of Gisborne.

Deep Creek, Jackson's Creek, and their tributaries have deeply dissected these plains, and it is chiefly along the bottoms and sides of these deep gutters that exposures of the sedimentary rocks are to be found.

The basalt plains are "infilled valleys,"[13] and mark the main valleys of the early Tertiary topography. Very often the altered gravels of these ancient valleys can be seen on the slopes

of hills that have since been covered by the volcanic rocks and have subsequently been laid bare. As is usual in these cases, "lateral" streams developed along the edges of the lava, e.g., Riddell's Creek to a point a mile west of Riddell; Charlie's Creek to the south and west of Mt. Eliza; Emu Creek to the north-west of Monegeetta; Jackson's Creek between Clarkefield and Sunbury; and the Deep Creek to the west of the basalt area.

Depressions or areas where the basalt sagged frequently enabled streams to flow across the main mass of lava. These valleys are very important, as along the course of these streams "windows" of underlying rocks are exposed. Many of these undoubtedly represent some of the minor divides of the pre-basaltic river system.

The Macedon mountains form a well-marked unit composed chiefly of granodiorite and dacite. To the south and east are the hills of conglomerates, and around this are the Ordovician hills which gradually slope to the basalt plains.

3. Previous Work and References.

1863.—The first geological reference[1] to these conglomerates is in Quarter Sheets 6 N.W. and 6 S.W., surveyed by C. D'O. Aplin, under the direction of A. R. C. Selwyn, Director of the Survey. In these maps the Palaeozoic rocks are marked as Lower Silurian (Ordovician of modern usage), and the conglomerates are mapped as a capping resting on these rocks. A note written across the outcrop is of some interest:—"Extensive beds of coarse conglomerate (carboniferous), consisting almost entirely of smooth rounded pebbles of a purple subcrystalline sandstone with an almost total absence of quartz pebbles, constitute the entire mass of these two parallel ranges with their various spurs and branches; coarse, gritty and fine-grained partially altered sandstones are sparingly interstratified with them. Thickness probably 500 feet or more."

Across "Conglomerate Gully" is another note:—"Fine section showing conglomerate beds exposed and weathered into large tabular masses; bedding obscure, but apparently horizontal."

In the legend the rock is marked as "Oolitic" (i.e., Jurassic).

The Survey roughly indicated the extent of the conglomerates, but no attempt was made to map their boundaries.

The account of the geology of this area with written by Norman Taylor.[2] In this the use of the term "Oolitic" is explained. "The tops of the Monument Range (Black Range), north of it (Mt. Eliza), and also the high densely scrubby ranges to the south have been marked on the maps of the Geological

Survey as carbonaceous (Oolitic) conglomerates lying unconformably (horizontally) on the upturned Silurian rocks." A footnote relative to this sentence is of interest, as it shows that further work was done in this area:—" Subsequent observations tend to place these conglomerates much lower, probably Devonian or Old Red." Unfortunately, I have been unable to trace records of this work.

The Survey thus recognised that the conglomerates were fairly horizontal, rested unconformably on the Ordovician rocks, and were Devonian in age. They show low dips for this series in their plans, and estimate its thickness as more than 500 feet.

1867.—A. R. C. Selwyn[3] mentions this conglomerate among others, and states:—" From Mt. Macedon eastwards, and especially near Mansfield and in the Gippsland localities, greater variations in the general character of the beds occur than is observed in the more western outcrop, and I am inclined to think that the Bacchus Marsh, Ballan, and Grampian Beds are newer than any we have in the eastern district." The Bacchus Marsh deposits are Permo-Carboniferous, so that in Selwyn's opinion the Kerrie conglomerates are older than these and younger than the Upper Ordovician.

1893.—T. S. Hart[5] described the Kerrie conglomerates and believed them to be pre-glacial (i.e., pre-Permo-Carboniferous). He is the first to name these conglomerates the " Kerrie conglomerates." He describes the lithology in detail, and states that they rest unconformably on the Lower Silurian (i.e., Ordovician) rocks.

1903.—Professor J. W. Gregory[7] makes a passing mention of these conglomerates.

1908.—T. S. Hall[8] identified *Climacograptus* sp., collected by A. E. Kitson at Kerrie, and states the age of the rocks in which the specimen occurs is either Upper Ordovician or Lower Silurian.

1912.—Professor E. W. Skeats and Dr. H. S. Summers[10] published their work, " The Geology and Petrology of the Macedon District." In this work references to the workers on the igneous rocks of the area will be found. They describe in detail the igneous rocks and their relationship to the sedimentary rocks, and show that the Kerrie series is intruded and metamorphosed by the granodiorite. They deal at some length with the Kerrie conglomerates. The following quotation (p. 8) summarises their views on this matter:—" This deposit is much thicker and considerably older than is shown by the Geological Survey Quarter-sheets. It may be unconformable to the Lower Ordovician (?) shales, but the appearances may be due to the folding together of hard and of plastic beds. It is closely

associated in places with Upper Ordovician shales, and apparently underlies them. The Devonian (?) granodiorite is intrusive into it. The conglomerate has been much sheared and compressed, and "dimpled" pebbles are common. Similar pebbles occur here and there in mudstones at the base of the Silurian series north-east of Romsey. We draw the inference that they are derived from the Kerrie conglomerate, to which we therefore assign a pre-Silurian age. We think that it probably forms the basal member of the Upper Ordovician series."

Other references to this work will be considered as occasion arises.

1912.—F. Chapman[11] identified shelly fossils collected by A. E. Kitson from the Parish of Kerrie, Allot. 18:—"The following forms were identified—*Heliolites* sp., casts of encrinite stems, *Platystrophia* sp., *Spirifer* sp., ? *Camarotocchia*, ? *Atrypa*. The fossil evidence points in a general way to a Yeringian (i.e., Upper Silurian) horizon, but is not entirely conclusive." These come from grits that are interbedded with Upper Ordovician shales.

1921.—W. J. Harris and W. Crawford[16] described in detail the Lower and Upper Ordovician rocks of the area, and show that the Djerriwarrh Fault runs through Gisborne and separates these two series. They also recognise a horizon of grits, the Riddell grits, at the top of the Upper Ordovician. They describe the relationship of the Upper Ordovician to the Kerrie conglomerates, and show that the conglomerates rest unconformably on the Upper Ordovician rocks and contain pebbles of fossiliferous Riddell grits. They conclude (p. 75) that the age of the conglomerate depends on the age of the Riddell grits, which pass under it, and in part at least, seem to have provided the material of which it is formed. These are probably Upper Ordovician, and it is probable that the conglomerate may be a basal Lower Silurian deposit.

In 1923 H. S. Summers in "The Geology of Mt. Macedon and Woodend Area"[18] summarised the position as follows:—"The Kerrie conglomerates were tentatively described as being possibly the basal members of the Upper Ordovician. Later work has been done by Harris and Crawford on the Lower Palaeozoic Rocks to the south of Macedon. They have come to the conclusion that these conglomerates rest unconformably on the Upper Ordovician Rocks, and belong to the basal part of the Silurian. Further work is necessary before either view can be definitely accepted."

Such was the position when the present work was undertaken, which is an attempt to marshal the facts and interpret them in the light of the field evidence.

4. Summary of Present Work.

1. It is shown that the rocks to the west of the Djerriwarrh Fault, Gisborne, and at Rochford belong to the top of the Darriwil.

2. Along Emu Creek at Bolinda and Monegeetta, "windows" in the basalt enable some cherts and diabases of the "Heathcotian," and some rocks of Bendigonian age, to be seen.

3. Between these areas the oldest rocks exposed are Upper Ordovician in age. This area is bounded by faults, of the rift valley type. Associated with the Upper Ordovician rocks are the "Riddell grits" of Harris and Crawford. These are Upper Ordovician in age, and apparently are not confined to one horizon.

4. The Kerrie series of conglomerates and sandstones rests unconformably on the upturned edges of the Upper Ordovician rocks, and nowhere comes in contact with Lower Ordovician rocks.

5. The age of the Kerrie series from direct evidence in this area is post-Upper Ordovician and prior to the granitic intrusions.

6. Some evidence is given that the Lower Ordovician and Upper Ordovician rocks are conformable, and, from work outside the area discussed here, there is no evidence of a post-Ordovician and pre-Silurian diastrophic period.

7. The age suggested for the Kerrie conglomerate is Upper Devonian.

5. Upper Cambrian and Ordovician Rocks.

In this area, Upper Cambrian, Lower Ordovician, and Upper Ordovician rocks are present. The Upper Cambrian rocks consist of cherts and diabases, while the Ordovician rocks consist of alternating sandstones, mudstones, shales, and grits. As Harris and Crawford have pointed out[16] (p. 54), it is a matter of great difficulty to separate individual outcrops of the Upper and Lower Ordovician rocks on lithology alone. The typical slates of the Lower Ordovician cannot be mistaken, but the Darriwil beds are lithologically very similar to the Upper Ordovician. Hard quartzose bands and grits are more characteristic of the upper division, and very often these contain fragmentary fossils.

(A) Heathcotian and Lower Ordovician.

As it has been suggested that the Kerrie series is probably the base of the Upper Ordovician,[10] some observations on the distribution and relationship of these groups are necessary. The

Lower Ordovician rocks outcrop outside the area mapped in detail. The area around Gisborne has been studied by Harris and Crawford,[16, 20] who state that at Gisborne the rocks are the top zone of the Darriwil, but further south, Castlemainian and Bendigonian beds appear. These are separated from the Upper Ordovician rocks to the east by the Djerriwarrh Fault. They point out that the downthrow is to the east, increasing to the south and probably disappearing under the Macedon platform. The alluvial flats near Barringo and the metamorphism of the rocks near the igneous rocks make it impossible to trace the fault in this area. (The zoning used is that of Harris and Keble).[27]

North of Macedon Castlemainian rocks outcrop west of Woodend, but to the east Darriwilian rocks extend right up to Lancefield.

The nearest fossiliferous outcrops of Lower Ordovician age to the north are the Upper Darriwilian rocks near Rochford. Somewhere between this place and Emu Creek is the boundary between the Upper and Lower Ordovician rocks. Further detailed work is necessary before this boundary can be fixed more accurately.

To the east along Emu Creek, near Clarkefield and Bolinda, small patches of older rocks occur. West of Monegeetta, cherts and associated volcanic ash beds are exposed, which under the microscope resemble the ash beds to the east of Romsey. Work in the Lancefield area has shown that the interbedded diabase does not extend to the base of the Lancefieldian, so that this patch has been mapped as "Heathcotian" (Upper Cambrian). These rocks strike N. 20° E. and dip at high angles to the east; they are on the flanks of the south-west continuation of one of the most important axial lines in Central Victoria. This is referred to as the Mount William anticlinorium.

South and a little east of the above exposure, cherty shales with phosphatic inclusions outcrop. In this patch the following fossils were obtained:—

Tetragraptus fruticosus (3-branched forms) (J. Hall).
T. cf. quadribrachiatus (J. Hall).
Phyllograptus cf. typus J. Hall.
Phyllocarids.

The horizon indicated is Middle Bendigonian, probably B3, but not older. These rocks are similar in strike and dip to those at Monegeetta and confirm the evidence that we are on the eastern flank of the Mount William anticlinorium.

(B) Upper Ordovician.

Lithologically these are similar to the rocks in the Darriwilian, but coarse grits, which have been called the Riddell grits, outcrop in many places. The rocks strike in a general north and south direction, although due to the pitch of the folds, strikes swing to the east and west of north. On the whole, the strikes are to the east rather than the west of north. Dips are invariably high and very often are perpendicular.

Four areas of Upper Ordovician rocks will be considered, viz., Riddell's Creek-Barringo Creek, Sandy's Creek, Running-Charlie's Creek, and the Emu Creek areas.

1. *Riddell's Creek-Barringo Creek.*—The few graptolite localities in this area are, however, sufficient to give the horizon of these beds. Loc. C/15, near Barringo Creek, was first found by Harris and Crawford.

Climacograptus bicornis var. peltifer Lapw.
Diplog. spp.

occur here and show that the rocks are a low horizon in the Upper Ordovician.

To the east of the mouth of Conglomerate Gully brown shales with thin blue partings outcrop beneath the conglomerate. Harris and Crawford found *Diplograptus* sp. here, and while revisiting this locality in company with W. J. Harris and R. A. Keble, we were fortunate enough to find a specimen of *Dicellograptus sextans,* thus definitely fixing the Upper Ordovician age of these rocks.

The other locality mentioned by Harris and Crawford is on the ridge to the west of Bracken Gully. This is marked C/16 on the map. On revisiting this locality several forms were found:—

Dicellog. cf. forchammeri Gein.
Diplog. (Amplexograptus) perexcavatus Lapw.
Diplog. (Amplexograptus) cf. arctus E. and W.
D. (Orthograptus) cf. quadrimucronatus (J. Hall).
Climacograptus minimus (Carr).
Cl. cf. exiguus H. and K.

The horizon indicated is higher than that of C/15 and the graptolites at the mouth of Conglomerate Creek.

On the south and west of the mass of conglomerates the rocks are thus definitely Upper Ordovician in age.

2. *Sandy's Creek and Area to the South.*—Along Sandy's Creek the rapid erosion of the creek has exposed good sections. The beds unfortunately are metamorphosed near the granodiorite. They strike consistently east of north from N. 5° E. to N. 40° E. and dips are high to the east.

Loc. C/3 is on the creek, and in the blue-black mudstones the following forms were found:—

Diplog. (Amplexograptus) perexcavatus Lapworth.
Diplog. sp.
Climacograptus sp.

S.W. of allot. 75, Parish of Kerrie, some brown shales locally contorted yielded species of *Diplograptus, Climacograptus,* and *Dicellograptus.* Unfortunately the forms as at Loc. C/3 are not well preserved.

Further to the east alluvium masks the underlying rocks. On the hill on the road between Monegeetta and Riddell, brown shales interbedded with typical Upper Ordovician grits occur. The beds strike east of north and dip to the west, indicating the eastern limb of the Riddell syncline.

Running Creek and Charlie's Creek.—Running Creek flows between Mts. Charlie and Teneriffe, while Charlie's Creek flows between Mt. Charlie and Mt. Eliza. Along Running Creek and on the hillsides, exposures are plentiful. Unfortunately the rocks are indurated and metamorphosed. The area is sharply folded and the sharp pitch of these folds causes the direction of the strike of the beds to vary considerably. Further downstream dips and strikes become more constant.

Badly preserved graptolites were found on the Mt. Charlie ridge in Allot. 144, Parish of Kerrie. Loc. C/2 is on the right bank of Running Creek. The graptolites occur in thin blue bands that are interbedded with brown shales and sandstones, and yielded:—

Dicellograptus sp.
Climacograptus sp.
Diplograptus cf. quadrimucronatus J. Hall.

On the watershed between Sandy's Creek and Running Creek a quartz-tourmaline-breccia is found, which was first recognised by Harris and Crawford. This outcrops near the Kerrie conglomerate, which is very quartzose in character here. The silification, tourmalinisation, and brecciation increase in intensity towards the granodiorite. In all probability these phenomena are connected with a fault line along which the vapours from the granodiorite altered the brecciated rocks. Fragments of partially digested bedrock are plentiful in a quartzose matrix, and in these the development of tourmaline is very noticeable.

Although exposures along Charlie's Creek are poorer, the rocks are more normal, so that well-preserved graptolites can be obtained.

At Loc. C/1 only imperfectly preserved graptolites were obtained.

At Loc. C/2 the following forms have been identified:—

Dicellograptus forchammeri var. flexuosus Lapw.
Dicellog. sp.
Diplograptus cf. quadrimucronatus J. Hall.
Diplog. sp.

Loc. C/4 is a very fossiliferous one, and yielded the following forms:—

Dicranograptus Nicholsoni Hopk.
Dicranog. ramosus J. Hall.
D. cf. furcatus J. Hall.
D. hians T. S. H.
D. hians var. apertus T. S. H.
Climacog. caudatus Lapw.
Climacog. sp.
Diplog. (Orthog.) cf. pageanus Lapw.
D. spp.
Cryptograptus tricornis var. insectus Rued.

At Loc. C/5 the following forms were obtained:—

Climacog. sp.
Cryptograptus tricornis (Carr).
Diplograptus cf. perexcavatus Lapw.
Dicranograptus cf. ramosus (J. Hall).
Dicranog. ramosus var. spinifer Lapw.

These beds strike N. 20° E. and dip to the east at 50°.

C/6 is a locality in the small tributary of Charlie's Creek. The exposure is a poor one, and so are the graptolites. *Dicranog* sp. and *Diplog.* were the only forms obtained.

4. *Emu Creek Section.*—South-east of Tye's good exposures of Upper Ordovician rocks occur. As usual they consist of sandstones, grits, shales, and mudstones. The strike, apart from some local deviations, is east of north and the dip is to the east of high angles. The graptolites occur in thin bedded soft blue-black mudstone. Being interbedded with more resistant, massive quartzose bands, they have suffered a great deal from the folding movements. Slickensided faces are so well developed that only with difficulty can well-preserved forms be obtained.

The fossil localities C/8 to C/13 follow each other in rapid succession downstream. Included in this lot is one locality mentioned by earlier workers.

The graptolites indicate that these beds are about the same horizon. Loc. C/10 yielded the following forms:—

Climacograptus bicornis (J. Hall).
Cl. tubuliferus Lapw.
Cl. sp.
Dicranograptus Nicholsoni Hopk.
Dicellograptus elegans Carr.
D. forchammeri var. flexuosus Lapw.
D. sp.
Cryptog. tricornis (Carr).
Diplog. spp.

From Loc. C/11 the following forms were obtained:—

Cl. bicornis (J. Hall).
Cl. putillus cf. mut. eximius Rued.
Cl. sp.
Diplograptus cf. truncatus Lapw.
Diplog. cf. truncatus var. intermedius E. and W.
Diplog. cf. truncatus var. pauperatus E. and W.
Diplog. calcaratus cf. var. vulgatus Lapw.
Cryptograptus tricornis (Carr).

At the other localities the only other forms worth mentioning are *Diplograptus* cf. *quadrimucronatus* (J. Hall) and *Dicranograptus hians* (T. S. Hall). Further downstream the covering of basalt and alluvial wash hides this most interesting section. A small patch of Upper Ordovician rocks dipping to the west occurs about half a mile downstream. The horizon of the beds on Emu Creek corresponds to those of Charlie's Creek and would correspond to the zone of *Dicranograptus clingani* in the British succession.

(C) The Riddell Grits.

This name was applied by Harris and Crawford[15] to a series of coarse sandstones and fossiliferous grits which outcrop in this area. They state that they represent a shallow-water facies of the Upper Ordovician and that they are associated with *Dicranograptus* beds. These grits outcrop in several areas, but the evidence obtained points to the fact that they are not confined to one definite horizon (which reconciles observations which perplexed Harris and Crawford[16] (p. 60) in the Gisborne area), but are interbedded with normal Upper Ordovician graptolite-bearing beds.

Typical exposures of these rocks are to be found:—(*a*) On the road between Riddell and Monegeetta, (*b*) at Riddell's Creek, near Conglomerate Gully and Bracken Gully, (*c*) in Sandy's Creek, and (*d*) between Running Creek and Charlie's Creek.

For the purposes of this paper the Riddell grits will not be considered as a definite horizon, and the detailed discussion of the horizons at which they occur will be left for a further date.

A full discussion of this problem and lists of fossils, &c., are to be found in the paper by Harris and Crawford.[16] As these grit bands are interbedded with Upper Ordovician graptolite shales their age is fixed.

1. The General Structure of Ordovician and Older Rocks, and the Relationship of the Lower and Upper Ordovician Rocks.

On the west the Upper Ordovician rocks have been shown by Harris and Crawford[16] to be bounded by the Djerriwarrh Fault. They have shown that the throw of this fault increases to the south and probably dies out towards the Macedon platform. No evidence of this fault was found near Barringo Creek, but this may be due to the metamorphosed character of the rocks in this area.

North of the Macedon platform, Lower Ordovician rocks are found in the Parishes of Rochford and Newham. The horizon indicated is high in the Darriwil series (D 1 zone), the nearest fossiliferous outcrop to the area under discussion being near Rochford. Here the presence of *Tetragraptus quadribrachiatus* proves conclusively that the beds are Lower Ordovician in age. Along Emu Creek the beds are Upper Ordovician in age and are fairly high in the sequence. More detailed work may place the boundary more accurately.

A consideration of the fossil evidence is interesting, as it definitely shows that there is no break between the Lower and Upper Ordovician rocks. Thus Ba 67, at the junction of Riddell's and Jackson's Creeks, represents the basal bed of the Upper Ordovician. Many forms are common to the lower beds of the Upper Ordovician and the uppermost beds of the Darriwilian, and it is only by careful examination that the beds can be separated. The D1 beds and the basal Upper Ordovician are predominantly *Diplograptus* shales. Both have large typical species of *Diplograptus*, probably of allied species, but distinct from *D. austrodentatus* H. and K. of the D2 beds.

That the fauna of the beds have much in common is shown by the following list of forms which are common to Upper and Lower Ordovician:—

Didymograptus caduceus Salter.
D. ovatus T. S. H.
D. spp.
Diplograptus euglyphus Lapw.

D. spp.
Climacograptus riddellensis Harris.
Cl. spp.
Glossograptus hincksii (Hopk).
Cryptograptus tricornis (Carr).

The absence of *Tetragraptus* and *Phyllograptus* is the criterion of separation of the beds of these series, but the incoming of the typical Upper Ordovician element is the deciding factor.

The great structural feature of this area is the south-westerly continuation of the Mount William anticlinorium. Along this line to the north are the cherts and diabases of Upper Cambrian age. On the west occur Lower Ordovician rocks which follow conformably on the Heathcotian series. These rocks are hidden by the basalt on the Riddell area, but their presence on the eastern limb is indicated by the Bendigonian rocks near Bolinda. Stratigraphically beneath these and with a similar strike of N. 20° E. are the cherts and associated diabasic rocks on Emu Creek near Monegeetta. These strikes show how the north-south Mt. William axis has developed a south-westerly trend. This twist takes place a little to the east of Romsey on the Deep Creek, as along the river sections here the beds have similar strikes. The same line must pass to the west of the junction of Riddell's and Jackson's Creeks, as the fossils at Ba 67 show that the bed is immediately above the Lower Ordovician. East of this is a synclinal structure with the north-easterly trend. In this is a development of typical Upper Ordovician rocks. This synclinal structure has been named the Clarkefield synclinorium.

To the west of the Mount William anticlinorium is the Riddell synclinorium. Further work can be expected to show that the structure is more complicated, as along Emu Creek and Charlie's Creek is a well-marked syncline, while the beds at C/16 indicate a higher horizon than either C/15 near Barringo Creek or the locality near the mouth of Conglomerate Creek. The general structure, however, of this area between the Djerriwarrh Fault with Lower Ordovician rocks to the west and the Mount William axis with Lower Ordovician and "Heathcotian" is a synclinal one.

The sequence on the eastern side of the Riddell synclinorium is probably not a complete one. There is a strong possibility of strike faulting along the eastern edge of this basin. It is very difficult to be certain of this, as the succession of Lower Ordovician rocks in the Lancefield area is a very attentuated one. Added to this is the southerly pitch of the rocks and lack of exposures. But, taking these factors into consideration, it is difficult to see how the thickness of Upper Ordovician beds

exposed on the western limb of the syncline along Emu Creek, and the thickness of Lower Ordovician rocks exposed on the flanks of the Mount William axis, further to the north, can be placed in their entirety on the eastern side of this syncline. This is the sole reason for suggesting that a strike fault is hidden beneath the basalt near Clarkefield (*vide* section, fig. 6).

Another interesting feature is that the south-south-westerly trend of the Mount William axis points towards Geelong,[25] where diabases similar to those of the Mount William area occur. Whether the Dog Rocks are on a continuation of the Mount William axis remains to be seen.

The south-westerly trend of this area is a feature of more than local significance as lines of similar trend are a feature of South-Eastern Victoria.[19]

Observations on the contact of the Upper and Lower Ordovician rocks are very few in the State.

Teale[15] describes how Upper Ordovician rocks in the Mount Wellington district rest apparently conformably on Upper Cambrian rocks, with no marked stratigraphical break which the palaeontological evidence demanded.

The same author[14] in describing the Howqua River area states:—" It would be unwise in the present state of our knowledge to attempt to mark the boundaries between the different members of the Lower Palaeozoic. We can only note that the succession probably ranges from Cambrian to Silurian, and no unconformity has with certainty yet been recognised in this area."

Howitt[17] in describing the phosphate deposits of the Mansfield Area shows that here Cambrian (?), Lower Ordovician, and Upper Ordovician rocks outcrop. The presence of *Tetragraptus approximatus* (J. Hall) and *Tetragraptus decipiens* T. S. Hall shows the presence of L1 beds. Further to the east, in Allot. 18B, Parish of Loyola, W. Baragwanath found specimens which have been identified by Keble as of Middle Bendigonian age (recorded in Fossil Register of Mines Department). In this area the structure is so confused that no definite conclusion as to the relationship can be reached.

In both the Mansfield and Mount Wellington areas we are dealing with some of the major structural lines of Victoria. Undoubted disconformities are present along these lines, but no structural break, pointing to a period of intensive earth movements followed by a prolonged period of denudation between the Upper and Lower Ordovician, has been recorded. This is in agreement with observations elsewhere in the State.

Another area where Upper and Lower Ordovician rocks occur is to the north of Benambra. Upper Ordovician rocks outcrop on Wombat Creek[6] and at Nariel.[21] The finding of *Phyllograptus nobilis*[27] on the Gibbo Creek shows that Darriwilian rocks are present in this area, but no observer has suggested that there is an unconformity under the one that occurs above the Upper Ordovician rocks. The Mount William anticlinorium is another of the major tectonic lines of the State, and along this the succession of Lower Ordovician rocks is a very attenuated one.

From the evidence available, no diastrophic period has been proved between the Upper and Lower Ordovician periods. The floor of the geosyncline was probably not stationary as the main axial lines of Victoria were being formed, and on these the movements were sufficient to cause attenuation and disconformities. In the intervening areas the process of sedimentation was uninterrupted and a full sequence of the rocks was formed. This would account for apparent breaks in the sequence along the geanticlines where no direct evidence of unconformities have yet been observed.

In the area under discussion the fringe of Darriwilian rocks around the Upper Ordovician rocks that occur in the southerly pitching syncline, the similarity of fossil content in the beds, and the similarity in lithology, all point to the absence of a stratigraphical break between the Lower and Upper Ordovician periods.

6. The Kerrie Series.

The term "Kerrie series" as applied here comprises the Kerrie conglomerates of T. S. Hart[5] and later workers and the associated sandstones, which rest unconformably on the Upper Ordovician rocks and which are intruded by the granodiorites.

(A) Distribution.

These sediments outcrop in three areas—a southern area in the region south of the "Gap" in Sandy's Creek, the central area near Mts. Charlie and Teneriffe, and the northern area along Emu Creek and the Black Range. The granodiorite north of the "Gap," Sandy's Creek, separates the southern from the central outcrop, while the Tertiary anorthoclase trachyte of Mt. Eliza covers the outcrops between the central and the northern outcrops.

The Southern Area.—The boundaries of this area can be roughly defined as granodiorite to the north and north-west,

basalt to the south and to the east. A border of Upper Ordovician rocks surrounds the conglomerate on the east and west, but to the south the main body of the conglomerate passes under the basalt.

North of Riddell's Creek the hills are covered with conglomerate. The eastern boundary is not very well marked, as the detritus from the conglomerate on the steep hill slopes covers any rock outcrops. The boundary can be definitely established along Sandy Creek and two of its tributaries, also near the mouth of Conglomerate Gully. The boundary as shown on the map is indefinite, and perhaps should swing further down hill than shown.

At the outcrops near the mouth of Conglomerate Gully is the lowest level of the occurrence of the conglomerates. Their outcrop continues south of Riddell's Creek until hidden by the basalt. A tongue of basalt overlies the conglomerate here.

To the west of Splitters' Track Gully the boundaries are most unsatisfactory. No conglomerate *in situ* is met with until well up the gully, yet a tongue of conglomerate is well shown on the ridge to the west and continues south until hidden by the alluvium in Riddell's Creek.

The conglomerate does not reach Barringo Creek, and is intruded on the north by the granodiorite.

Inside this area massive conglomerates outcrop. To the east of Mt. Robertson and the northern part of Conglomerate Gully to Sandy's Creek no outcrops of conglomerate occur, their place being taken by hard, fairly fine-grained sandstones, very similar lithologically to some of the bands in the Upper Ordovician age. The field evidence, however, shows that these beds overlie the basal conglomerate of the Kerrie series.

The Central Outcrops.—This area is bounded by granodiorite on the south and west, while to the north are the lavas from Mt. Eliza. Running Creek and Charlie's Creek cut through the outcrops of the conglomerates. The geological relationships in the area between Mt. Teneriffe and Mt. Charlie are clear. The basal conglomerate is well developed and coarse, except near Mt. Teneriffe, where it thins out. The unevenness of the floor of Upper Ordovician rocks is well shown, but the upper limit is more uncertain, as there is a gradual transition from coarse conglomerate into sandstone. The conglomerate being hard resists erosion, and the Mt. Charlie ridge is due to its hard resistant nature. Between the conglomerate and the granodiorite exposures are few, and were it not for the stratigraphic position

of the sandstones on the hill to the south-west of Mt. Eliza, they could be taken on lithological grounds as belonging to the Upper Ordovician.

The upstream trend of the conglomerate is well shown, pointing to an upstream dip. Actual dip measurements were obtained along the road west of Flume Gully, and in two "wash outs" on the opposite side of the valley.

The conglomerate in several places forms cliffs, and the inhospitable nature of these beds is indicated by the timber. The eastern slope of Mt. Charlie has well developed timber, but on the summits and western slopes along the conglomerate, the vegetation is stunted, the change taking place abruptly.

As is usual with basal conglomerates, they vary a great deal lithologically and in thickness. The conglomerate in places passes rapidly horizontally and vertically into sandstones. The conglomerate in the central area is thickest near the summit of Mt. Charlie, but thins abruptly towards the north. Near Charlie's Creek, where the outcrop is ill-defined, it is about a chain wide, and near Mt. Teneriffe it is not much thicker.

The Northern Outcrop.—This forms the Black Range—a thickly timbered range running in a north-westerly direction from Emu Creek towards Hesket.

Along Emu Creek the conglomerate can be followed as a narrow belt between Emu Creek on the north and the volcanic rocks to the south. Further upstream the conglomerate crosses the creek, and can be traced to the road cutting and then along the range. The north-western end is not clearly shown, but the conglomerate is not seen on the Romsey-Hesket road. A small patch of granodiorite occurs at this end, and is probably continuous with the area further west.

Above the point where the conglomerate crosses Emu Creek are sandstone beds dipping to the south-west at a comparatively low angle, and upstream the metamorphosed breccia-conglomerate is well shown. Resting on this breccia-conglomerate some sandstone beds occur.

(B) Lithology of the Series.

The Kerrie series consists of alternating sandstones and conglomerates which vary rapidly both vertically and laterally. The sandstones are generally brownish in colour, are much indurated, and resemble many of the Upper Ordovician sandstones.

The basal conglomerate is the more massive member of the series, and generally the larger pebbles are well rounded, although

the smaller ones are often subangular. It forms, as a rule, a hard cemented mass of pebbles, the largest ones being about 2 feet in diameter. For the most part the pebbles are of quartzite, subcrystalline sandstone, brown micaceous sandstones, and grits, which lithologically and palaeontologically cannot be separated from the grits of the underlying series. Some of these pebbles of grits, as at the Survey locality Ba 74, contain fragmentary shelly fossils such as occur in the Upper Ordovician grits. Where the size of the pebbles as a whole is smaller than usual, they become subangular.

Skeats and Summers[10] (p. 37) have described in detail the mineralogical changes that take place in the conglomerates and sandstones when metamorphosed by the granodiorites, and the slides that have been examined support their conclusions. Some distance away from the granodiorites, however, in areas where the conglomerates appear normal, as along Emu Creek and Bracken Gully, a few feet at the base of the conglomerate and the top of the Upper Ordovician, have been silicified so that the actual contact is masked. A similar phenomenon has been described by A. W. Howitt[4] from the base of the Devonian conglomerates in North Gippsland.

Generally speaking, bedding planes cannot be recognised in the conglomerate, and dips can only be obtained in the finer grained impersistent bands. Where the sandstones are well developed, there is no difficulty on this account. Jointing and shearing are well developed. These pass indiscriminately through pebbles and matrix, giving perfectly flat faces. In some places these are so regular that only on closer inspection is their true character revealed. Slickensided faces are rare and are nowhere well developed. The jointing has a marked effect on the topography in Conglomerate Gully. Tributaries cut along these, and this, coupled with the weathering along softer planes, gives a cliff-like tiered topography.

"Dimpled pebbles" are common. According to Skeats and Summers, the "dimpling" is probably due to solution under pressure of neighbouring pebbles. The abundance of dimpled pebbles in the Kerrie conglomerate and their occurrence in conglomeritic shales in Lower Silurian strata at Springfield[10] and Jackson's Creek, where the dimpled pebbles are not in contact with each other, has given rise to the idea that these pebbles were derived from the Kerrie conglomerate. Dimpled pebbles, however, are not confined to the Kerrie conglomerate. E. J. Dunn[8] reports and figures "dimpled" pebbles from the Stockdale to Dargo road. These are from a Devonian cong'omerate.

Skeats[21] found dimpled pebbles in the Devonian conglomerates at Tabberabbera. In the Geological Survey Museum there are dimpled pebbles from Freestone Creek, Briagolong, of Upper Devonian or Lower Carboniferous age, collected by W. H. Ferguson. A. W. Howitt (personal communication) records them from Wappan, near Maindample. "Dimpled" pebbles are thus of common occurrence in conglomerates. However, no conglomerates older than the Silurian have been found in Victoria, but the dimpled pebbles may have been derived not from the Kerrie conglomerate but from some other source. In this connexion it is interesting to note that igneous pebbles have been found in these Silurian conglomerates, while continued search has failed to reveal any in the case of the Kerrie conglomerate. This points to different sources of origin for the Silurian and the Kerrie conglomerates.

7. Critical Sections.

Five areas where the relationship of the rock groups are well shown will be described:—

(A) Emu Creek-Black Range, near Tye's (Fig. 1).

This has been described by Skeats and Summers[10] and by Harris and Crawford.[16] The road cutting and the creek give two sections almost parallel to each other and along the Romsey water race some exposures are also seen. Lava flows occur south of the creek, which has carved a valley around these. Along and north of the creek Upper Ordovician rocks and the Kerrie series outcrop.

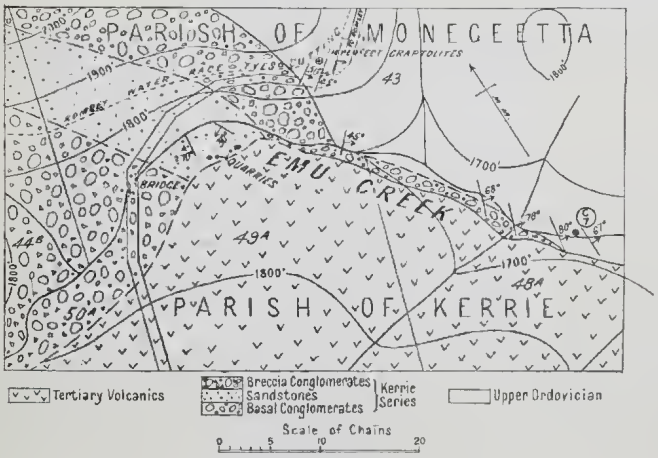

Fig. 1.—Emu Creek—Black Range.

In the road cutting, the Upper Ordovician sandstones are seen. No fossils were found in these, but some blue sandy shales a little below the race yielded some badly preserved *Diplograpti*. They were too badly preserved to be identified with certainty, but from their general appearance look like the Upper Ordovician forms. These rocks strike N.E. and dip S.E. about 50°. Further to the west the conglomerate is well shown. The actual junction is hidden. When traced both up the hillside and down to the creek, the boundary of the conglomerate is almost at right angles to the strike of the Upper Ordovician rocks.

The belt of conglomerate forms the southern bank of Emu Creek. In the creek the strike of the underlying sandstones is at right angles to the conglomerate. Silicification along the junction of the conglomerate makes it difficult to see the actual junction of the two systems. The creek flows along the conglomerate for some distance, but exposures are not continuous. On the sharp slope to the creek the conglomerate can be seen *in situ*. Where a small creek enters Emu Creek from the south, good exposures of the lava flow and the underlying conglomerate occur. A small patch of Ordovician sandstone lies in the creek bed, and here again the strike would carry these rocks right under the conglomerate. About 2 chains downstream from this point is the last exposure of conglomerate. Below this point only Upper Ordovician sandstones and shales are seen, the latter being very fossiliferous.

Upstream from the point where the conglomerate crosses the creek exposures for a while are poor. Some quarries and small exposures show sandstones. The strike of these is west of north, and the dip is to the south-west at about 30°.

North of the bridge occur good exposures of the altered breccia conglomerate. In this section the Upper Ordovician undoubtedly underlies the Kerrie series with an angular unconformity.

(B) Mt. Charlie-Teneriffe (Fig. 2).

In the area between Mt. Charlie and Mt. Teneriffe, the Running Creek, its tributary Flume Gully, two washouts on the flanks of Mt. Charlie, and a road cutting give good sections.

The physiography is controlled by the hardness of the conglomerate bed and by the granodiorite to the west. The basal conglomerate thins out towards Mt. Teneriffe, and the actual peak is made up of a quartzite of Upper Ordovician age. This passes into a well-defined quartz tourmaline breccia, well shown on the smaller peak S.W. of Teneriffe. The brecciation on this line increases towards the granodiorite. It is a local phenomenon, and is connected with a small fault or crush zone.

The general form of the outcrop is interesting, as it shows a distinct upstream bend. Near the mouth of Flume Gully, along the road cutting, and in the "washouts" to the south-west of Mt. Charlie, the sandstones are well shown. They strike N.N.E. to N.E., and the dip is westerly between 25° and 30°. The passage from conglomerate to sandstones is gradual—nowhere is a sharp demarcation found such as is seen between the Upper Ordovician and the conglomerate. On Mt. Charlie some trenches show the minor folding of the Upper Ordovician, and these are almost at right angles to the conglomerate outcrop. At the same time it should be noticed that the strike of these minor folds does not agree with the general direction of strike over the area. Many of the minor folds in the vicinity have different strikes. The Upper Ordovician rocks are much metamorphosed, and no fossils were found in this area.

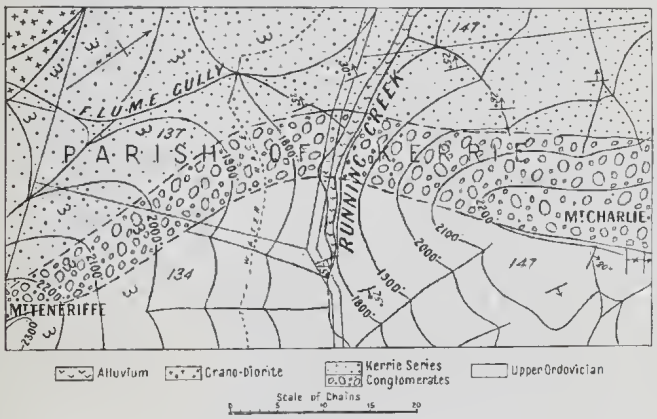

Fig. 2.—Mt. Charlie—Teneriffe.

The relationship of the Kerrie series is thus the same as at Emu Creek.

(C) "The Gap," Sandy Creek (Fig. 3).

The "Gap" is a well-marked physiographic feature. The Sandy Creek valley north of this point is fairly wide. The valley narrows where the line of conglomerate crosses the creek, while downstream the valley widens again. Tongues of granodiorite intrude and metamorphose the conglomerate and further downstream the Upper Ordovician sediments. These latter consist mainly of quartzose beds, striking north-east with easterly dip. These are well shown as the creek has deeply entrenched itself, and has cut a deep channel through the alluvium. This erosion is recent, and is probably due to cultivation. On the hills to the south it is very difficult to mark

with any degree of accuracy the base of the conglomerate, as the hill slopes are covered with debris from the conglomerate. Along some of the gullies this has been taken away for road metal, and along these "dry" gullies erosion is very active. In one of these bedrock has been exposed, thus enabling observations of dip and strike to be obtained.

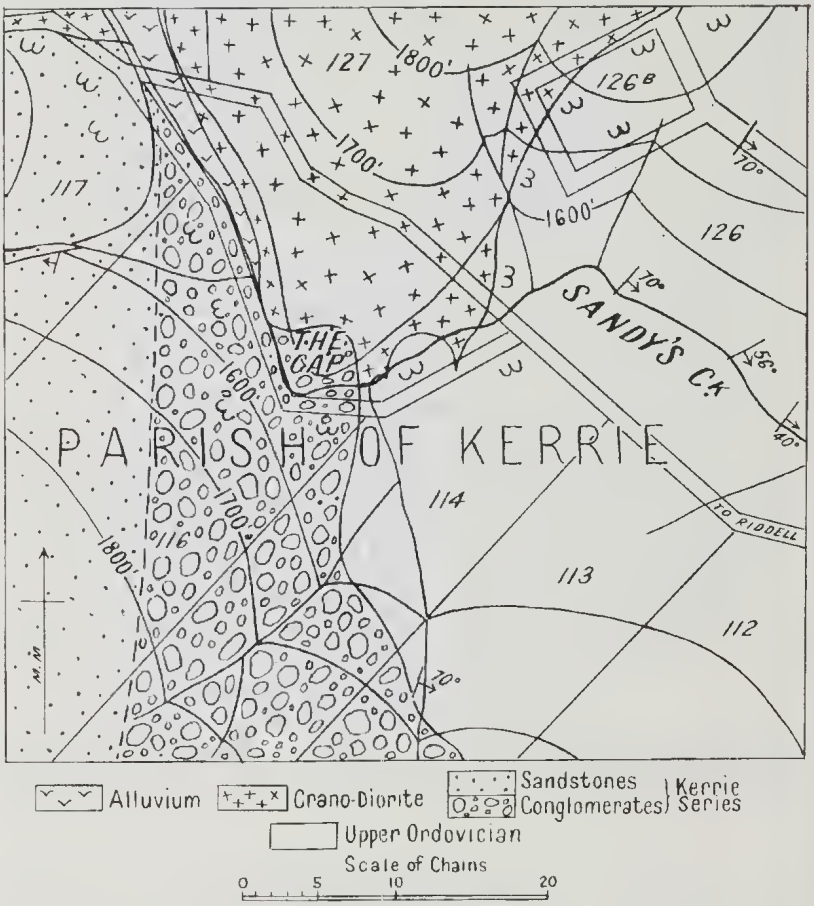

Fig. 3.—"The Gap," Sandy Creek.

(D) Near the Mouth of Conglomerate Gully (Fig. 4).

This area has been described in detail by Harris and Crawford[16] (p. 66), and also by Skeats and Summers, who published a photograph of this section[10] (pl. xxvii.). The south boundary of Allot. 108, Parish of Kerrie, is formed by Riddell's Creek. This creek at the south-east corner of the block flows over basalt, then a small flat is reached. At the western end of this the conglomerate is at creek level. East of the cliff,

some vertical shales and mudstones are seen striking north and south, and are interbedded with beds of grit, which can be traced for some distance up the hill. West of the conglomerate cliff vertical grits, shales, and mudstones can be seen underlying the conglomerate. The exact boundaries are rather difficult to see, as hill creep and surface wash nullify accurate observation. The brown mudstones contain thin blue bands in which Harris

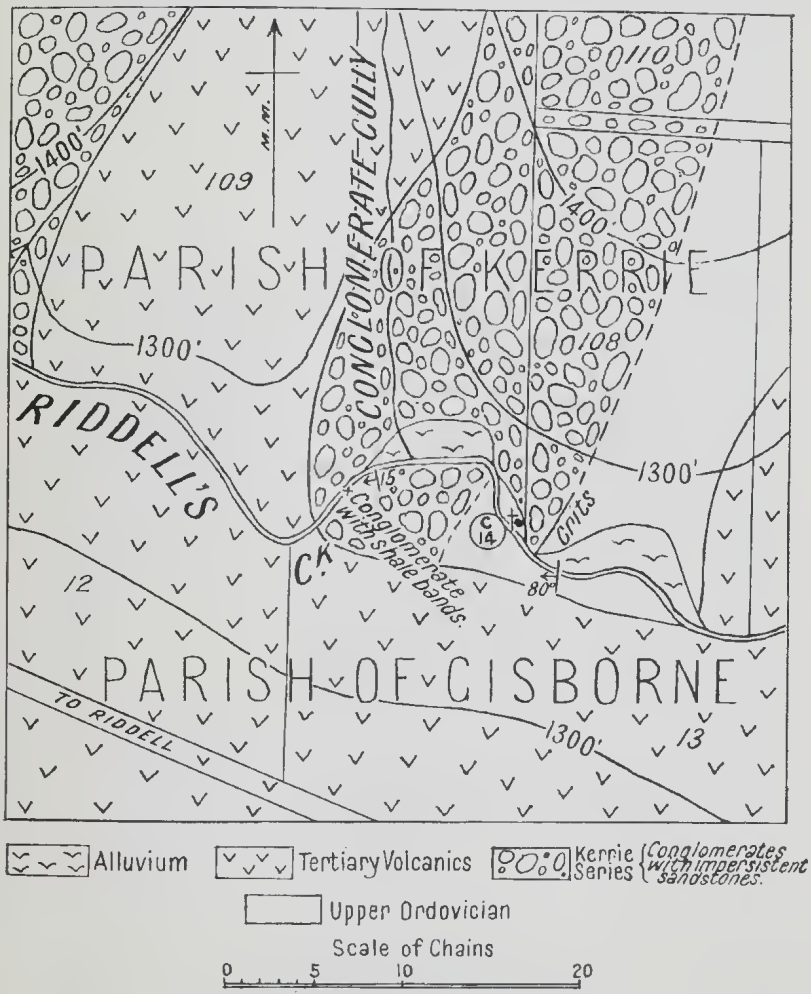

Fig. 4.—Conglomerate Gully.

and Crawford found *Diplograpti* sp. At a subsequent visit *Dicellog. sextans* was found. This fixes the age of the underlying series in this section as Upper Ordovician. A little west of the mouth of Conglomerate Gully, before reaching the patch

of basalt which crosses the creek, conglomerates are exposed on the south side of Riddell's Creek. They contain sandy beds, and the dip from these, although not well defined, is south-westerly at 15°, the strike being a little west of north.

(E) Bracken Gully (Fig. 5).

This section was also described in some detail by Harris and Crawford[16] (p. 66):—"In a small gully west of Conglomerate Creek, grits appear to pass under Kerrie conglomerate. The grits outcrop in the floor of the gully. As the stream is followed northwards a small waterfall is reached. The lower 4 or 5 feet are grit. Above lie impersistent layers of shale, and then the main mass of the conglomerate. The shales on the hillside to the west yielded numerous specimens of poorly preserved *Diplograpti*, and similar fossils are found lower down the gully."

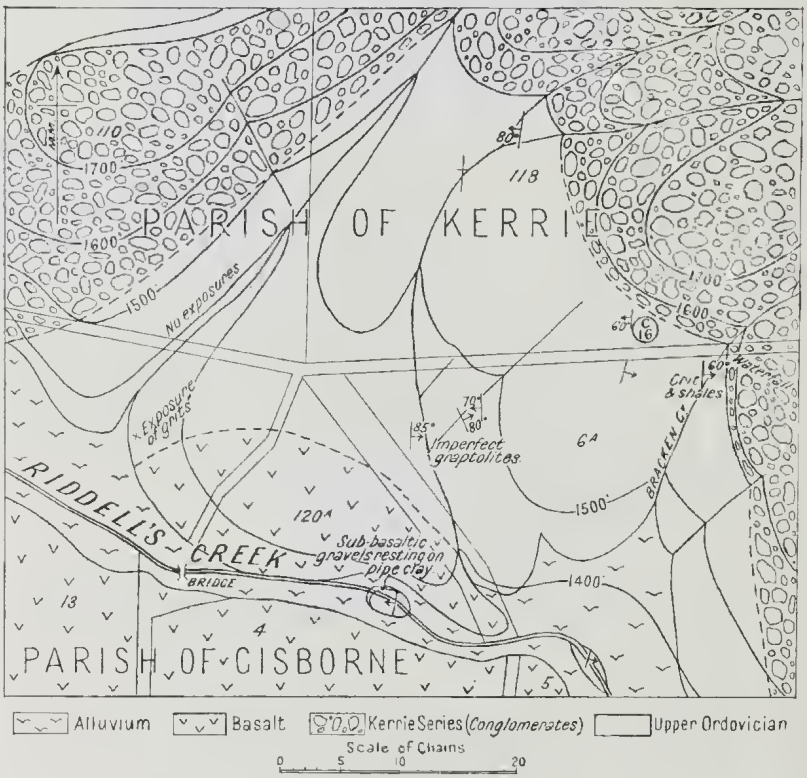

Fig. 5.—Bracken Gully.

The unconformable relationships of the rock groups are clearly shown in this sketch. The Upper Ordovician rocks consist of shales, sandstones and grits, folded at high angles with a general

north-south strike. Imperfectly preserved graptolites of undoubted Upper Ordovician age were found in the gully to the west of Bracken Gully and on the ridge between the gullies, a few chains away from the conglomerate, is the locality C/14 mentioned by Harris and Crawford.

The line of outcrop of the conglomerate trends north-west until Splitters' Track Gully is reached. No exposures were seen on the lower course of this creek, yet Kerrie conglomerate is found along the ridge to the west. The boundary is fairly definite on the ridge, and the conglomerate can be seen *in situ* on the sharp slope to Riddell's Creek. This outcrop appears to be a tongue of conglomerate from the main body.

(F) Review.

The similarity in structure, lithology, and geological relationship of the three areas of the conglomerates and associated sandstones shows that they are really one unit. This has been intruded by the granodiorite, &c., which separates the southern from the central outcrop, while the lava flow of Mt. Eliza hides the series between Charlie's and Emu Creeks.

In all cases the Kerrie series rests unconformably on the Upper Ordovician rocks, and they nowhere come in contact with rocks of Lower Ordovician age.

Taken as a whole, the Kerrie series occupies a synclinal basin on the Upper Ordovician rocks. This basin has a north to south axis, and the general slope is to the south. On the northern flanks of the Black Range the base of the series is about 2,000 feet above sea level, and at Emu Creek it is under 1,700 feet, which is the lowest exposed level, while near Conglomerate Gully the observed lowest level is just under 1,300 feet. The highest point reached is just over 2,500 feet at the Black Range. The thickness of the series as taken from the section is between 500 and 1,000 feet.

The exposures along the eastern flank show a decided westerly dip; observations along the western flank are unsatisfactory The surface of Upper Ordovician rocks on which the series rests is very uneven, but from a consideration of the levels of the base of the Kerrie series, there must be an easterly dip in the western area. The observed dips are from 20°–30°, but in the centre of this basin there is a tendency for the dips to be higher. Owing to the smallness of the exposures and the possibility of hill creep, these have not been recorded on the map.

The basal conglomerate of the series is well marked, but varies a great deal in thickness. Near Mt. Robertson this is followed by a series of sandstones. Near the Black Range two conglomerates occur and two thick sandstone beds are present, and it appears as if the upper conglomerate is lens-shaped and passes laterally into sandstone.

8. The Age of the Kerrie Series.

Owing to the incomplete nature of the stratigraphic succession in this area, and the absence of fossils apart from the derived ones in pebbles of the conglomerate, it is difficult to assign an age to the Kerrie series. Two sets of facts give an upper and lower limit to their age. The Kerrie series must be younger than the Upper Ordovician and older than the granodiorite intrusions.

Since the Kerrie series rests with an angular unconformity on the Upper Ordovician rocks, it must be younger than the fold movements which have affected them. Harris and Crawford, on the supposition that the Silurian rocks rest unconformably on the Upper Ordovician, and that the granite intrusions were Lower Devonian in age, suggested a Silurian age for the Kerrie series.

The question of the relationship of the Upper Ordovician and Silurian of this portion of Victoria has yet to be treated in detail. The preliminary statement can be made that there is no evidence of a period of intense earth movements in neighbouring areas in pre-Silurian times, such as could give rise to the angular unconformity at the base of the Kerrie series.

On the northern extension of the Clarkefield synclinorium there are conglomerates similar to the normal interbedded ones that occur in various parts of the State. Nothing approaching the nature of basal conglomerate has been found in the Silurian rocks of the neighbouring areas. It is on evidence such as this that the statement is made that there is no unconformity between the Ordovician and Silurian rocks.

The Kerrie series must thus be younger than Silurian.

The question of the age of granodiorites has undergone a complete change since Ferguson[12] showed that they intruded the Grampian sandstone. A summary of the probable ages of the various intrusions has been given by Skeats.[26] Hills[19, 20] has shown that Upper Devonian sediments are followed by rhyolites on which dacites rest. These dacites are intruded by granodiorites; so that the age suggested for the granodiorites is about the close of the Devonian period. Skeats and Summers[10] have shown that dacites and granodiorites of similar composition occur in the Macedon area, and that the granodiorites metamorphose the dacites. There is thus strong grounds for considering the granodiorites of the Macedon area as of the same as those described by Hills, i.e., they must be post-Upper Devonian in age.

The Kerrie series must, on these grounds, be Devonian in age. To fix the age more definitely presents some difficulties. No sedimentary rocks of Lower Devonian age have yet been found in Victoria, but the Kerrie series presents a strong similarity to

beds of Upper Devonian age as described by Howitt.[4] These are described as occupying hollows on a great Palaeozoic rock foundation, and are themselves gently folded.

It is on this close similarity that an Upper Devonian age is suggested for the Kerrie series.

9. The Tertiary and Later Rocks.

The only fossiliferous rocks of sedimentary origin younger than the Kerrie series in this area are the sub-basaltic gravels and sandstones. In Allotment 13, Parish of Kerrie, some basaltic clays with abundant plant remains were found (Loc. C/17). These have been examined by Mr. R. A. Keble, F.G.S., Palaeontologist of the National Museum, who states:— "The moulds of seeds in the sub-basaltic clay from Gisborne are unusually plain and show distinctly the peduncles, the hirsute tests, and some examples, the stigma and portion of the sepals. They may, with confidence, be referred to the genus *Eutaxia*. As there is only one representative of *Eutaxia* in our existing flora, and there is no essential difference between the moulds of the seeds examined and those of *Eutaxia empetrifolia*, the living form, they may be referred to that species." The presence of plants of present-day type beneath the basalts shows how recent are these flows.

Two sets of igneous rocks occur in this area; the granodiorite, granodiorite porphyrites, and dacites, which from evidence elsewhere have been given an Upper Devonian[7] age, and the suite of Tertiary lavas. These have been fully described by Skeats and Summers in their work on the Macedon area.

The only mineral observed in the anorthoclase trachyte of Mt. Eliza not recorded by them is much-resorbed biotite. In several instances the only indications of its former occurrence are rectangular patches of magnetite crystals. Fortunately the change has not proceeded as far in some cases, in which biotite can be identified.

Basalts and rocks approaching basalts in composition, such as the andesitic basalt and the macedonite along Emu Creek, have been treated as one unit on the map, as the relationship of these will be dealt with on a future occasion.

The youngest formation in the area is the deposits of alluvium. Some of these are quite thick, and are due to the basalt flows damming back the streams. At the present day the streams are cutting into these, and along Sandy's Creek over 50 feet of alluvium is exposed.

10. Summary of Geological History.

1. Deposition of Cambrian and Ordovician Rocks.
2. Intense folding of these rocks, their uplift and erosion after the close of the Silurian period.

3. Deposition of the Kerrie series on an uneven surface of Upper Ordovician age.
4. Gentle Folding of the Kerrie conglomerate probably at the close of the Devonian period.
5. Igneous activity in post-Upper Devonian times—the dacites being intruded by the later granodiorites.
6. A period up to Tertiary times of which no evidence has been preserved in this area.
7. A renewal of igneous activity in Tertiary times. This necessitated extensive alterations in the drainage system. Many temporary lakes were formed in which alluvium was deposited. No attempt has been made to work out the Tertiary geology in detail.

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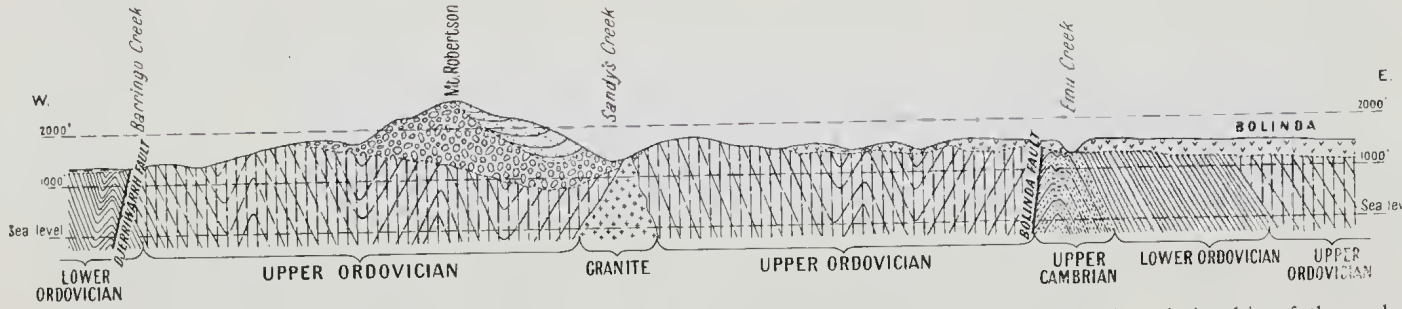
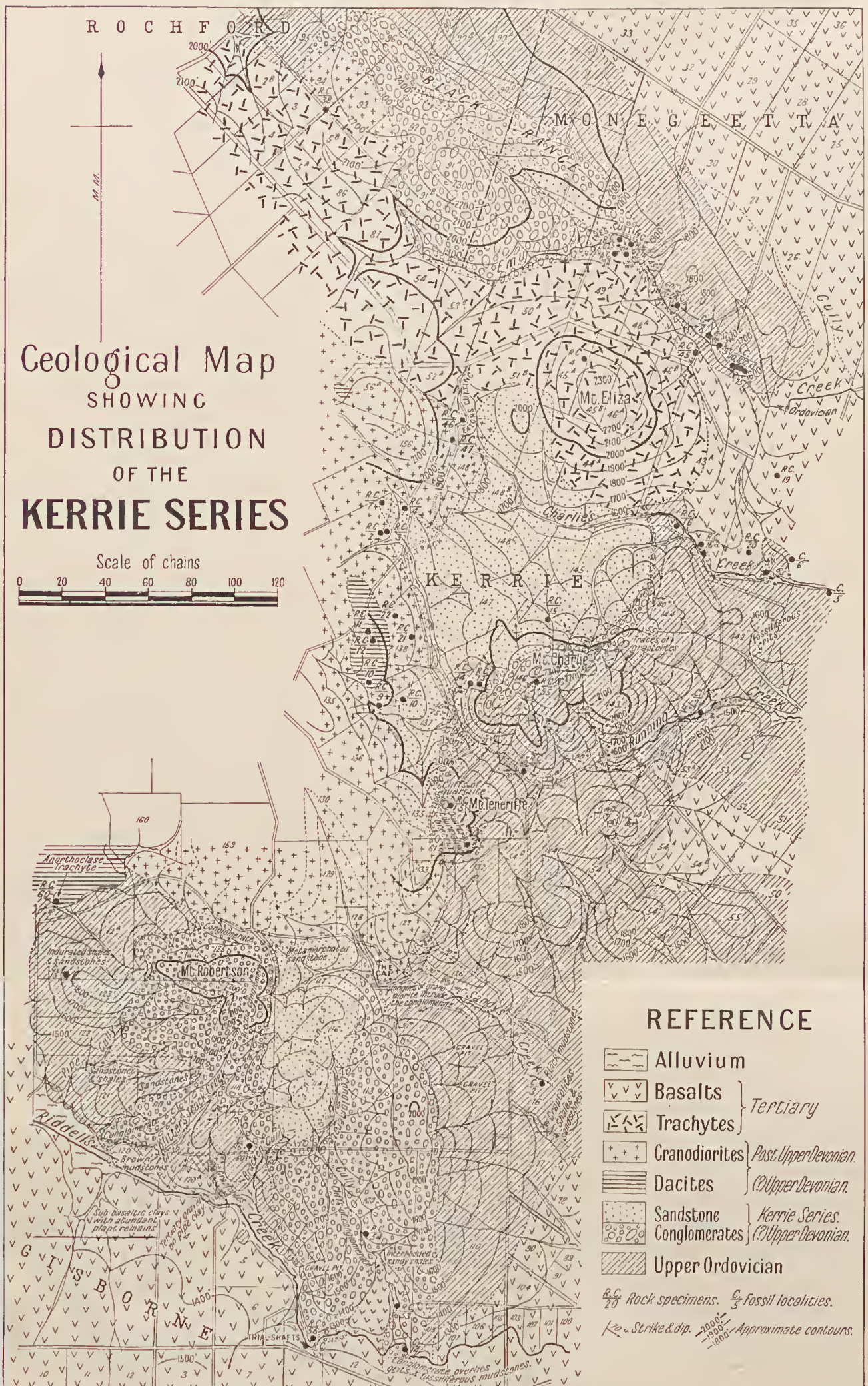


FIG. 6.—Diagrammatic section from point N. of Gisborne through Mt. Robertson to Bolinda to show the relationship of the rock groups. Length of section, 8 miles.



Geologically & topographically surveyed by D E Thomas, B.Sc., Mines Department Victoria 1931.

Drawn A.E.K.